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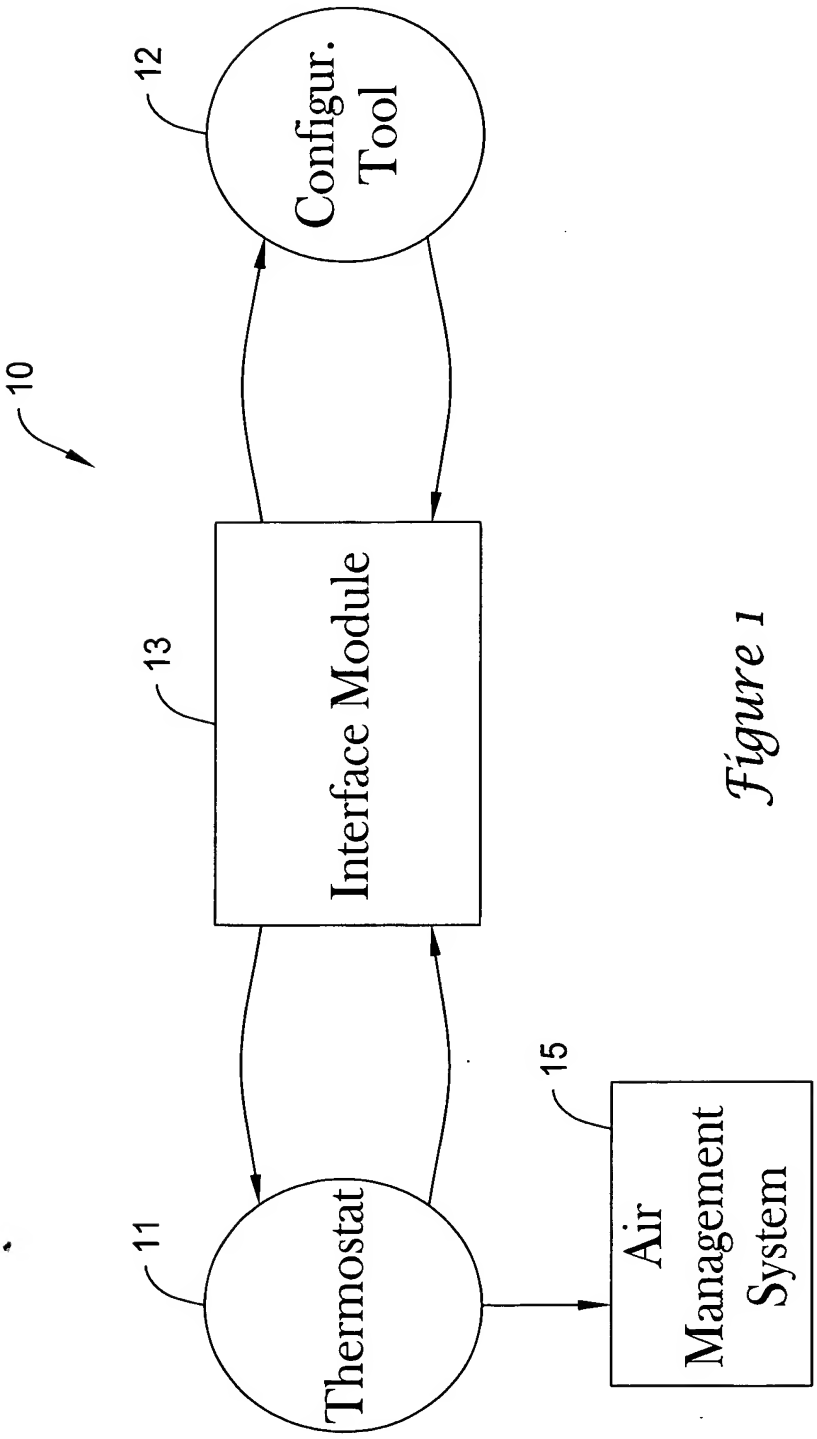


Figure 1

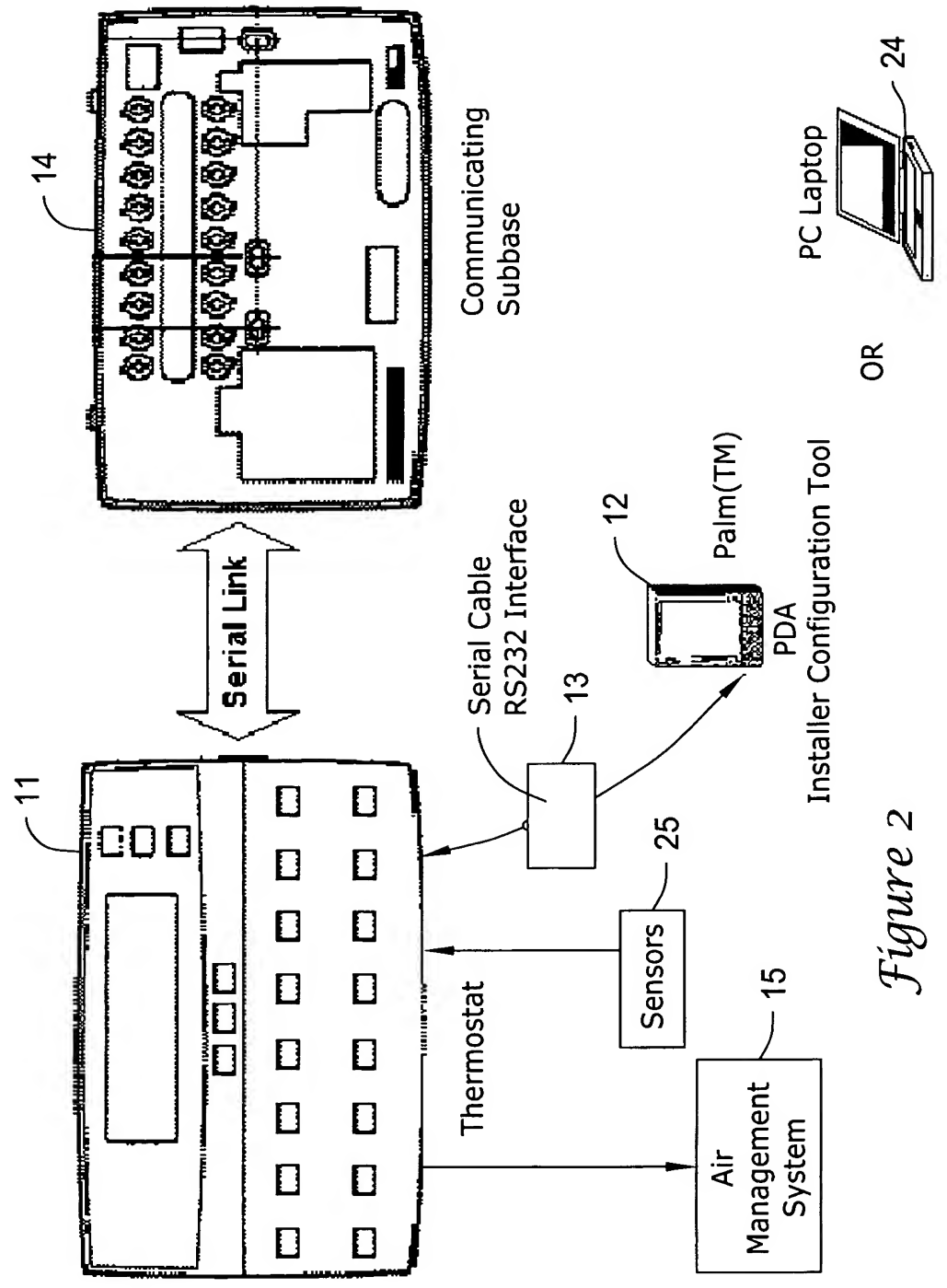

14
Communicating Subbase
PC Laptop
24
OR
Serial Link
Serial Cable RS232 Interface
12
Palm(TM) PDA
Installer Configuration Tool
13
11
25
Sensors
Thermostat
15
Air Management System

Figure 2

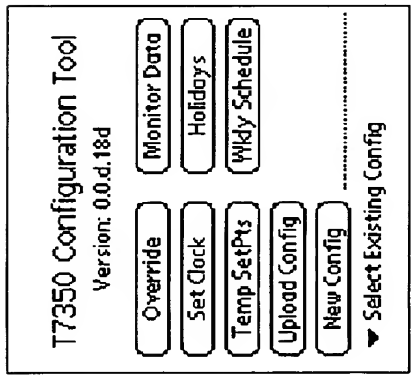


Figure 3A

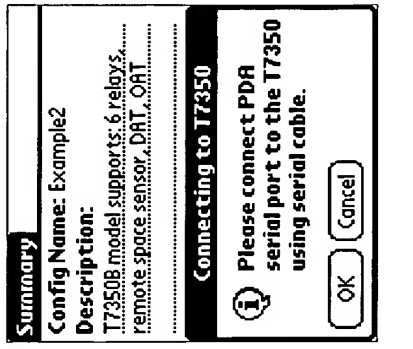


Figure 4C

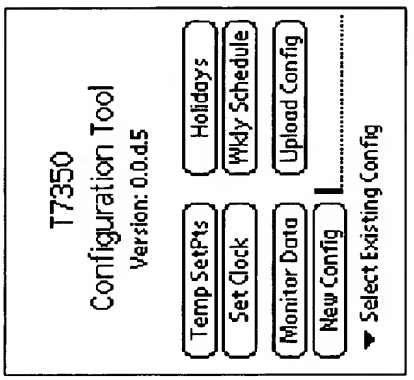


Figure 4A

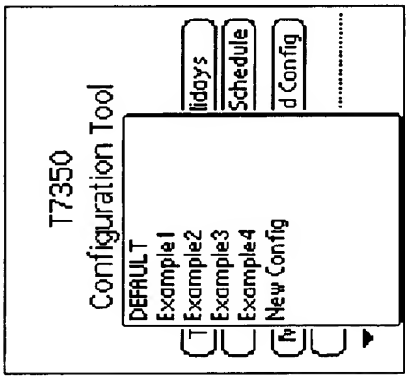


Figure 4D

Figure 4B

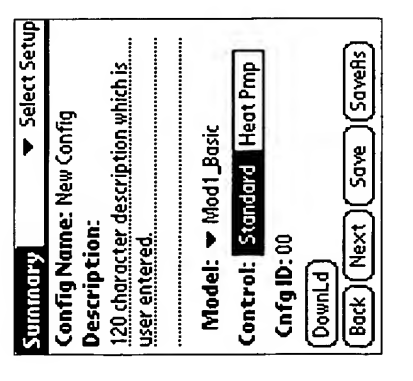


Figure 3B

Figure 5A

Figure 5B

Figure 5C

Figure 6A

Figure 6B

Figure 6C

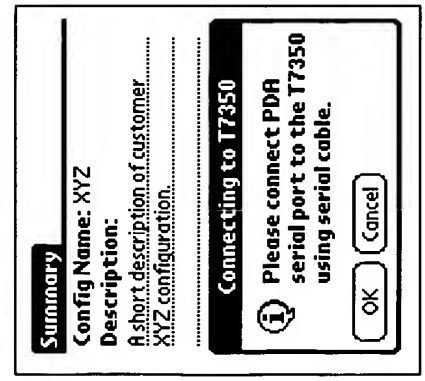


Figure 6D

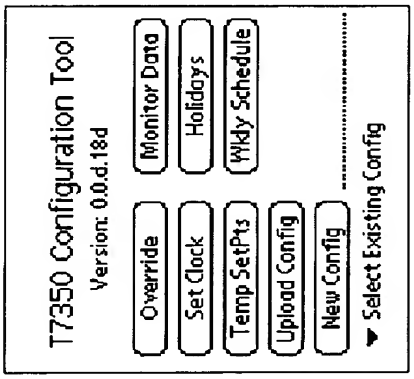


Figure 7A

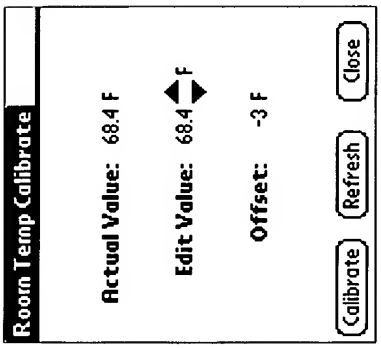


Figure 7B

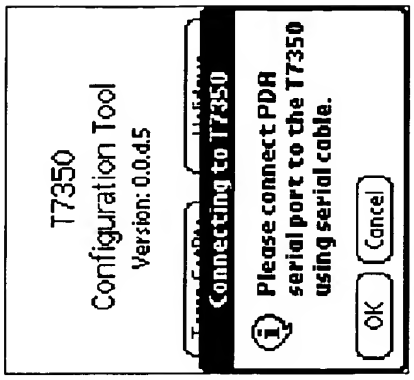
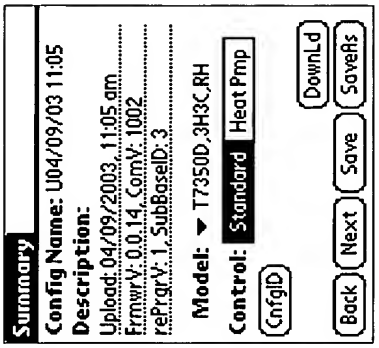


Figure 8B



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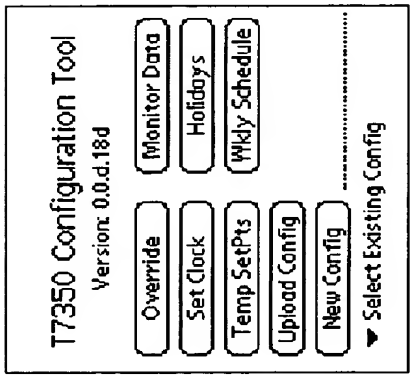

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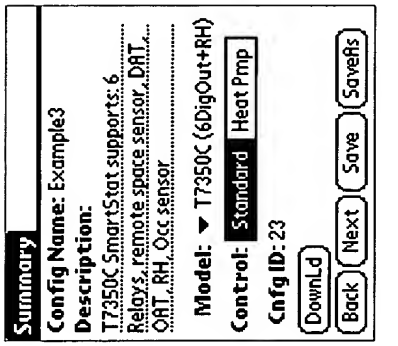

Figure 9A

Figure 8E

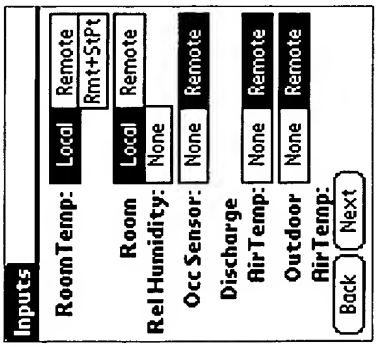

Figure 9C

Figure 9B

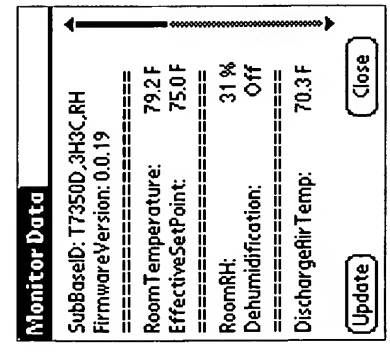

Figure 9D

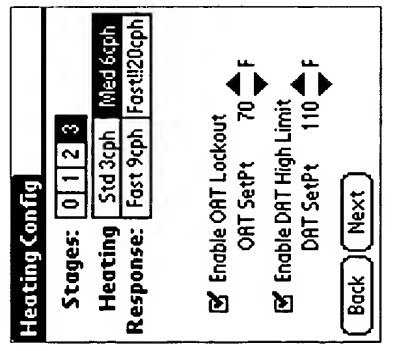

Figure 9E

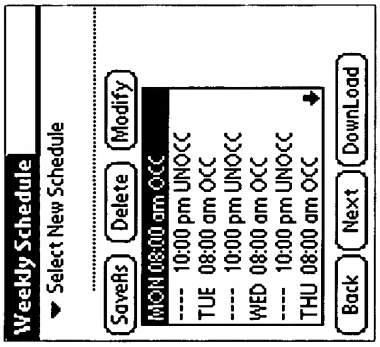

Figure 9G

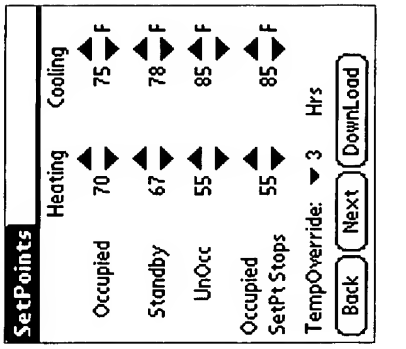

Figure 9I

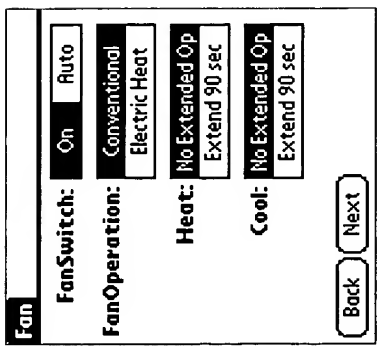

Figure 9F

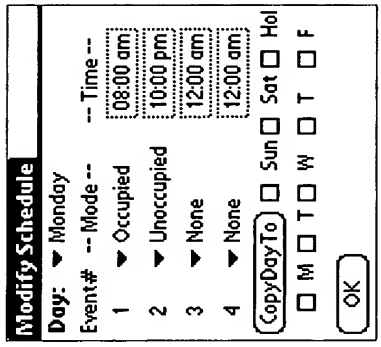

Figure 9H

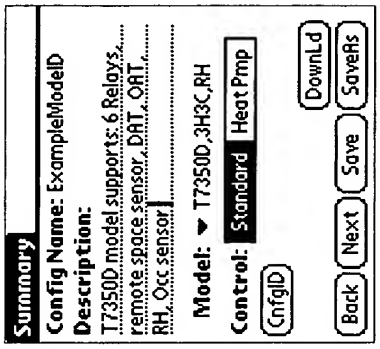

Figure 9J

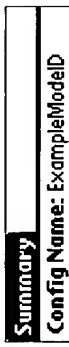

Figure 10A

Figure 10B

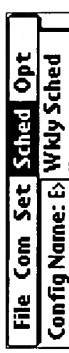

Figure 10C

Figure 10D

Figure 10E

Figure 10F

Figure 10G

Figure 10I

Figure 10K

Figure 10H

Figure 10J

Figure 10L

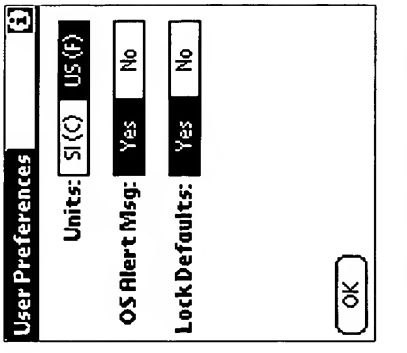

Figure 11A

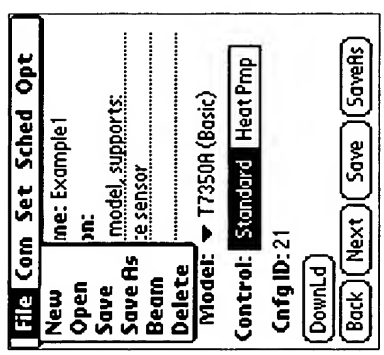

Figure 12A

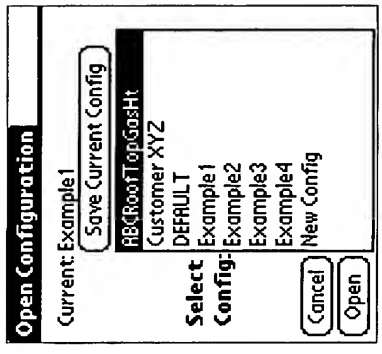

Figure 12C

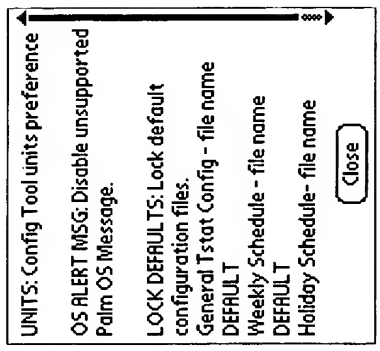

Figure 11B

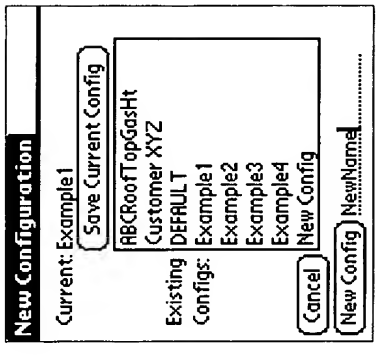

Figure 12B

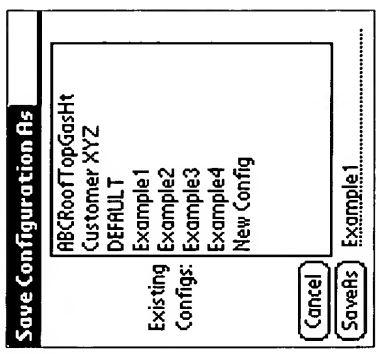

Figure 12D

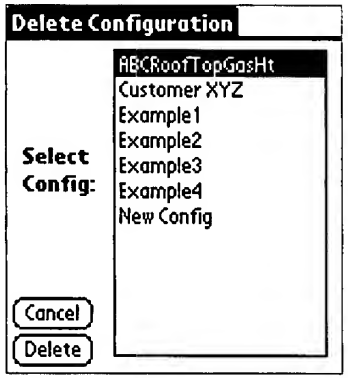

Figure 12E

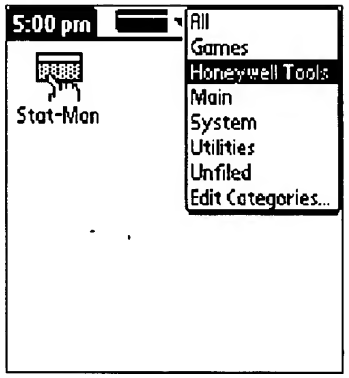

Figure 14A

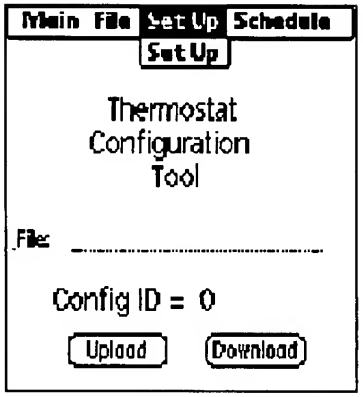

Figure 14C

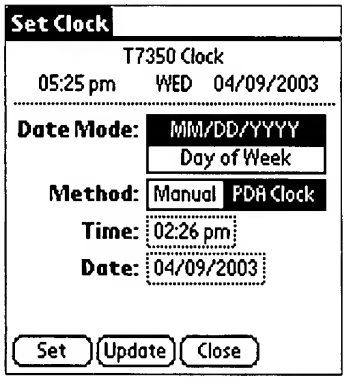

Figure 13

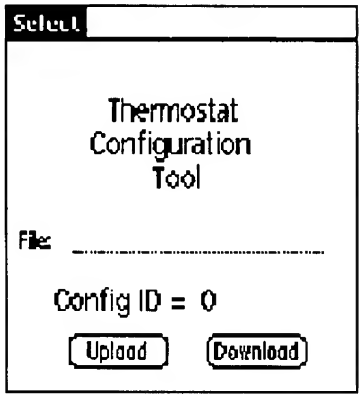

Figure 14B

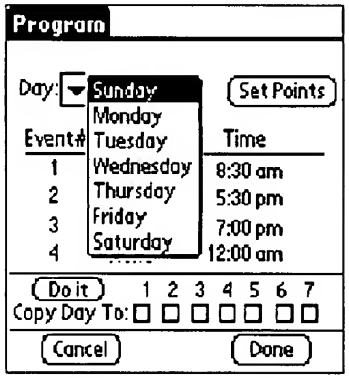

Figure 14D

Figure 14E

Figure 14G

Figure 14I

Figure 14F

Figure 14H

Figure 14J

Figure 14K

Figure 14L

Figure 14M

Figure 14N

Figure 14O

Figure 14P

Figure 14Q

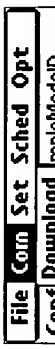

Figure 14S

Figure 14T

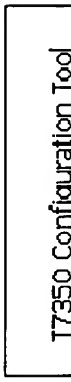

Figure 14U

Figure 14V

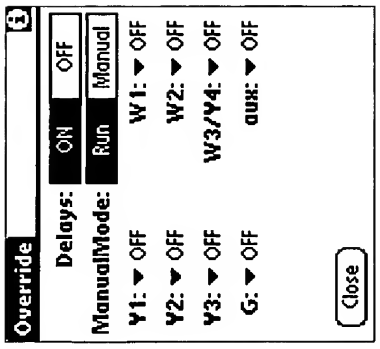

Figure 14W

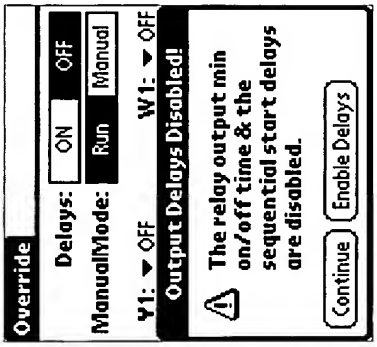

Figure 14Y

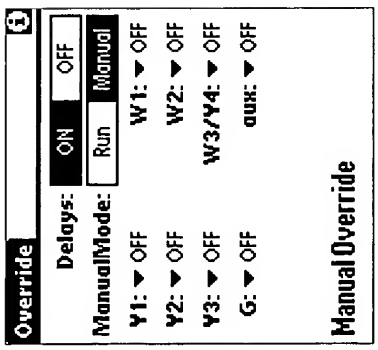

Figure 14Z

Figure 14X

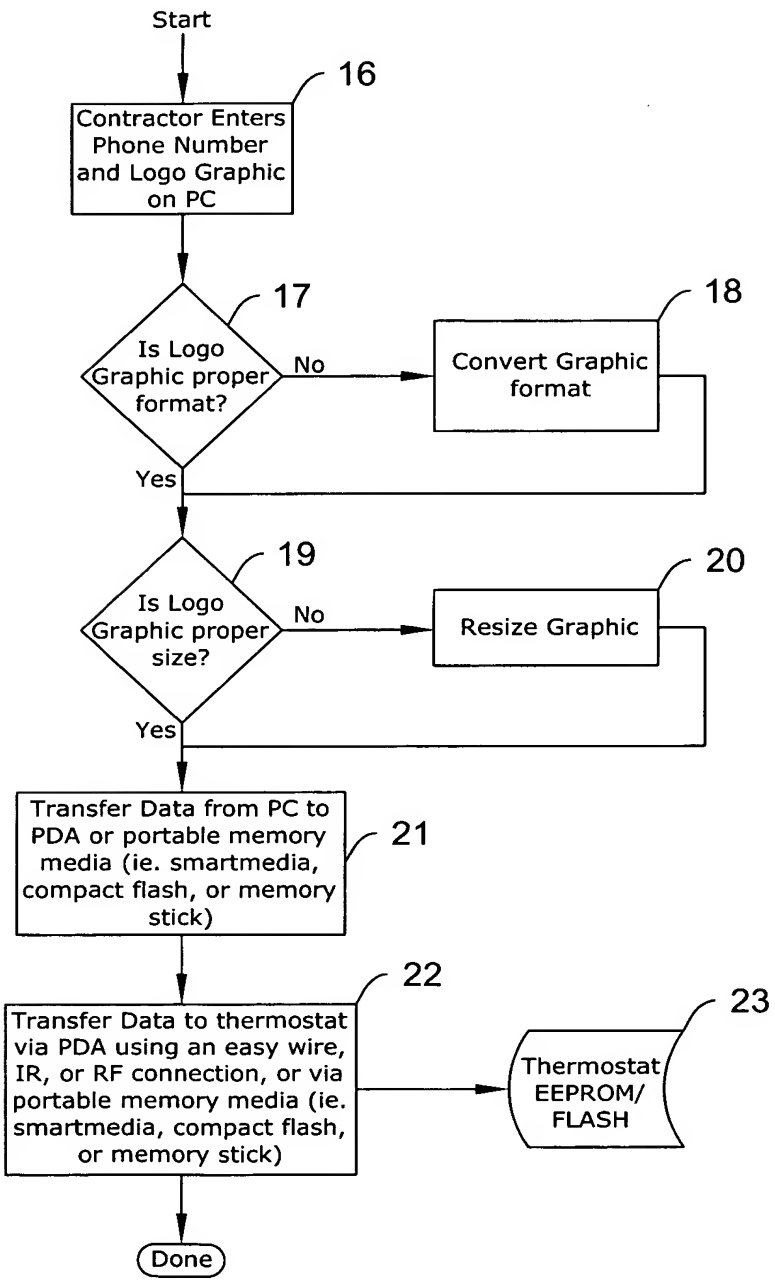
Start
16
Contractor Enters Phone Number and Logo Graphic on PC
17
Is Logo Graphic proper format?
No
18
Convert Graphic format
Yes
19
Is Logo Graphic proper size?
No
20
Resize Graphic
Yes
Transfer Data from PC to PDA or portable memory media (ie. smartmedia, compact flash, or memory stick)
21
22
Transfer Data to thermostat via PDA using an easy wire, IR, or RF connection, or via portable memory media (ie. smartmedia, compact flash, or memory stick)
23
Thermostat EEPROM/ FLASH
Done

Figure 15

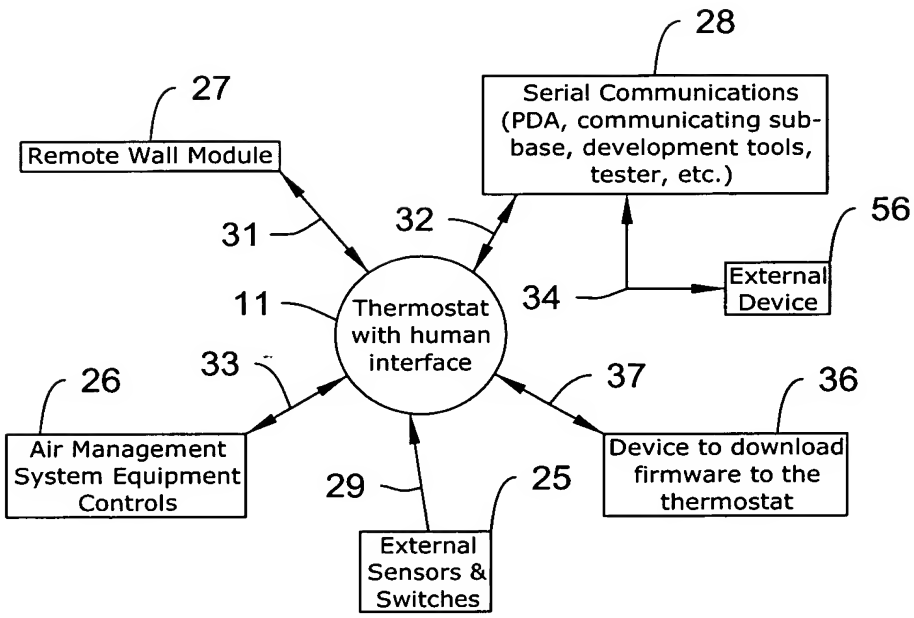
28
Serial Communications (PDA, communicating sub-base, development tools, tester, etc.)
27
Remote Wall Module
31
32
56
External Device
34
11
Thermostat with human interface
33
26
37
36
Air Management System Equipment Controls
Device to download firmware to the thermostat
29
25
External Sensors & Switches

Figure 16

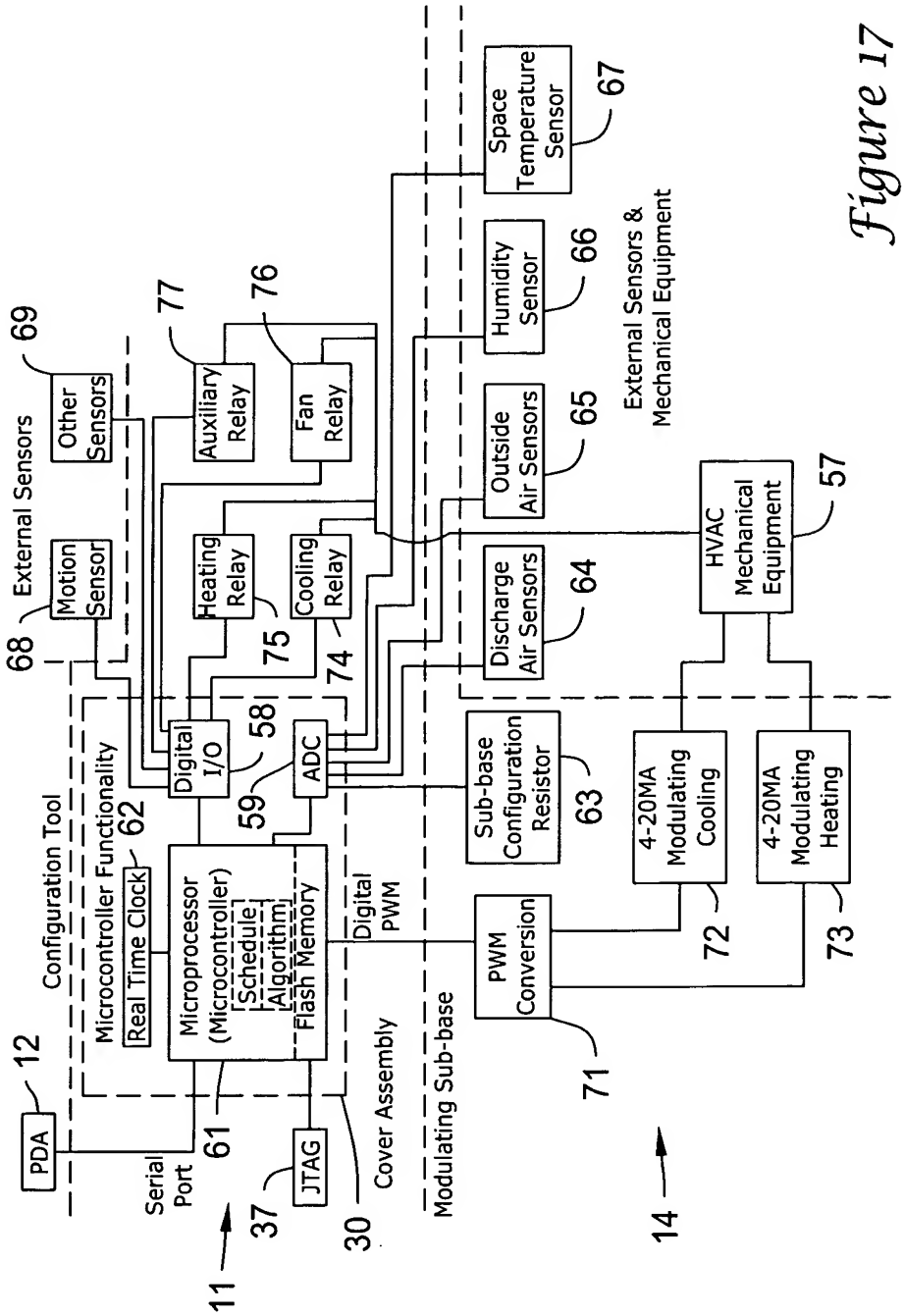
Configuration Tool
Microcontroller Functionality
Real Time Clock
62
Microprocessor (Microcontroller)
Schedule
Algorithm
Flash Memory
Digital I/O
58
59
ADC
Digital PWM
PDA
12
Serial Port
61
JTAG
37
11
30
Cover Assembly
Modulating Sub-base
PWM Conversion
71
Sub-base Configuration Resistor
63
4-20MA Modulating Cooling
72
4-20MA Modulating Heating
73
14
HVAC Mechanical Equipment
57
External Sensors & Mechanical Equipment
Discharge Air Sensors
64
Outside Air Sensors
65
Humidity Sensor
66
Space Temperature Sensor
67
External Sensors
Motion Sensor
68
Other Sensors
69
Heating Relay
75
Cooling Relay
74
Auxiliary Relay
77
Fan Relay
76

Figure 17

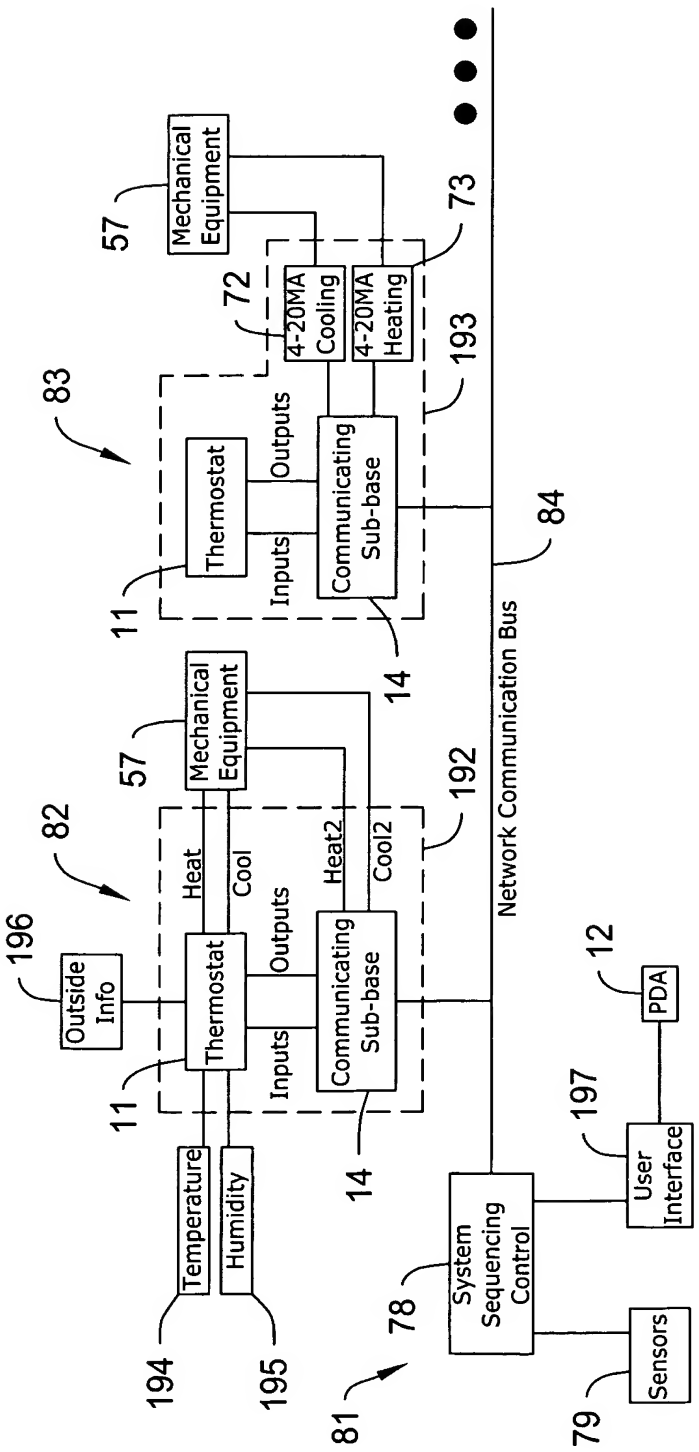
Network Communication Bus
Outside Info
196
Thermostat
Communicating Sub-base
Heat
Cool
Heat2
Cool2
Outputs
Inputs
11
14
82
192
Mechanical Equipment
57
Temperature
Humidity
194
195
81
System Sequencing Control
78
Sensors
79
User Interface
197
PDA
12
83
193
72
4-20MA Cooling
4-20MA Heating
73
84

Figure 18

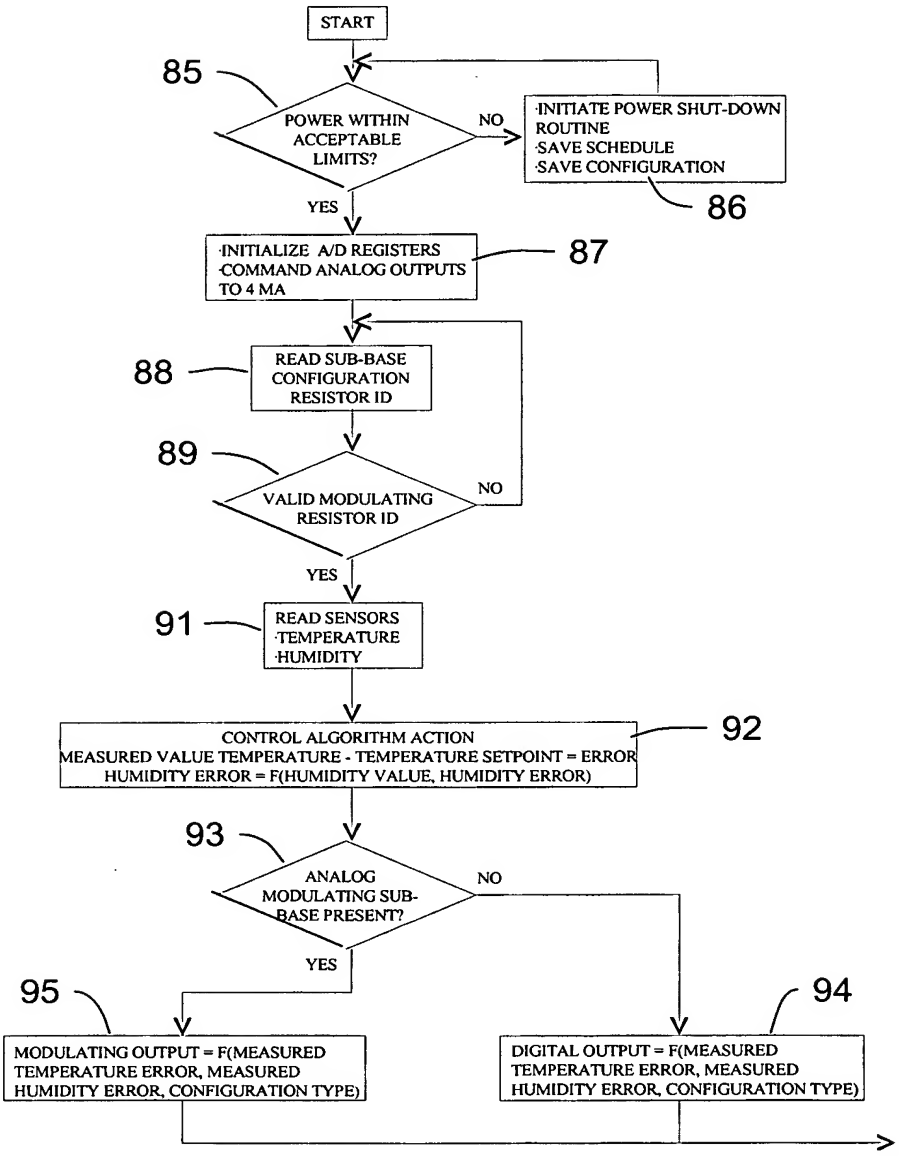
START
85
POWER WITHIN ACCEPTABLE LIMITS?
NO
·INITIATE POWER SHUT-DOWN ROUTINE
·SAVE SCHEDULE
·SAVE CONFIGURATION
86
YES
·INITIALIZE A/D REGISTERS
·COMMAND ANALOG OUTPUTS TO 4 MA
87
88
READ SUB-BASE CONFIGURATION RESISTOR ID
89
VALID MODULATING RESISTOR ID
NO
YES
91
READ SENSORS
·TEMPERATURE
·HUMIDITY
CONTROL ALGORITHM ACTION
MEASURED VALUE TEMPERATURE - TEMPERATURE SETPOINT = ERROR
HUMIDITY ERROR = F(HUMIDITY VALUE, HUMIDITY ERROR)
92
93
ANALOG MODULATING SUB-BASE PRESENT?
NO
YES
95
94
MODULATING OUTPUT = F(MEASURED TEMPERATURE ERROR, MEASURED HUMIDITY ERROR, CONFIGURATION TYPE)
DIGITAL OUTPUT = F(MEASURED TEMPERATURE ERROR, MEASURED HUMIDITY ERROR, CONFIGURATION TYPE)

Figure 19

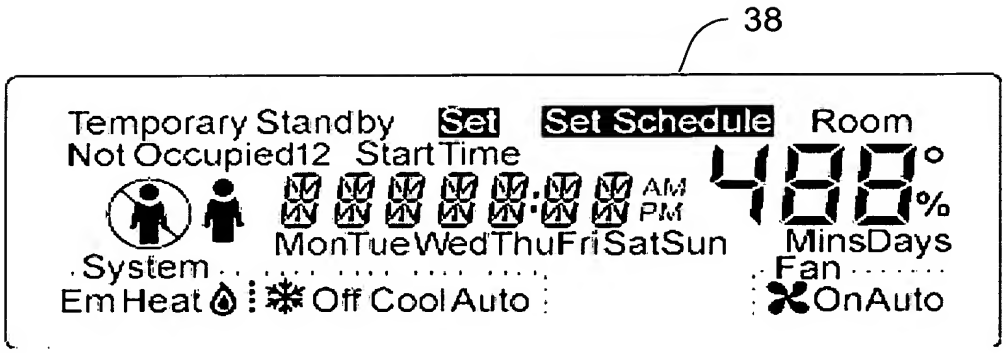

Figure 20A

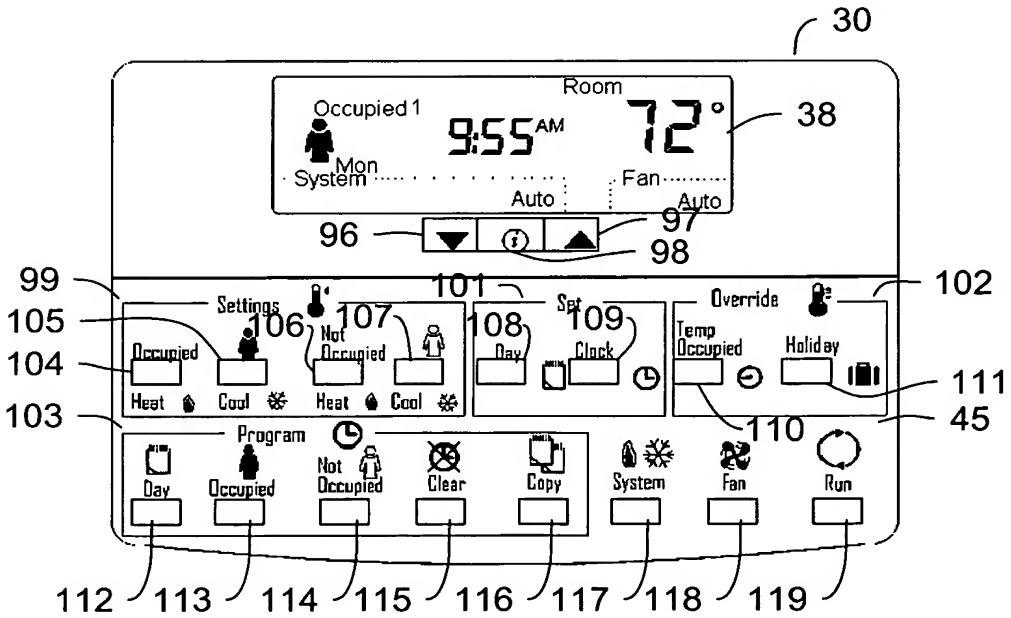

Figure 20B

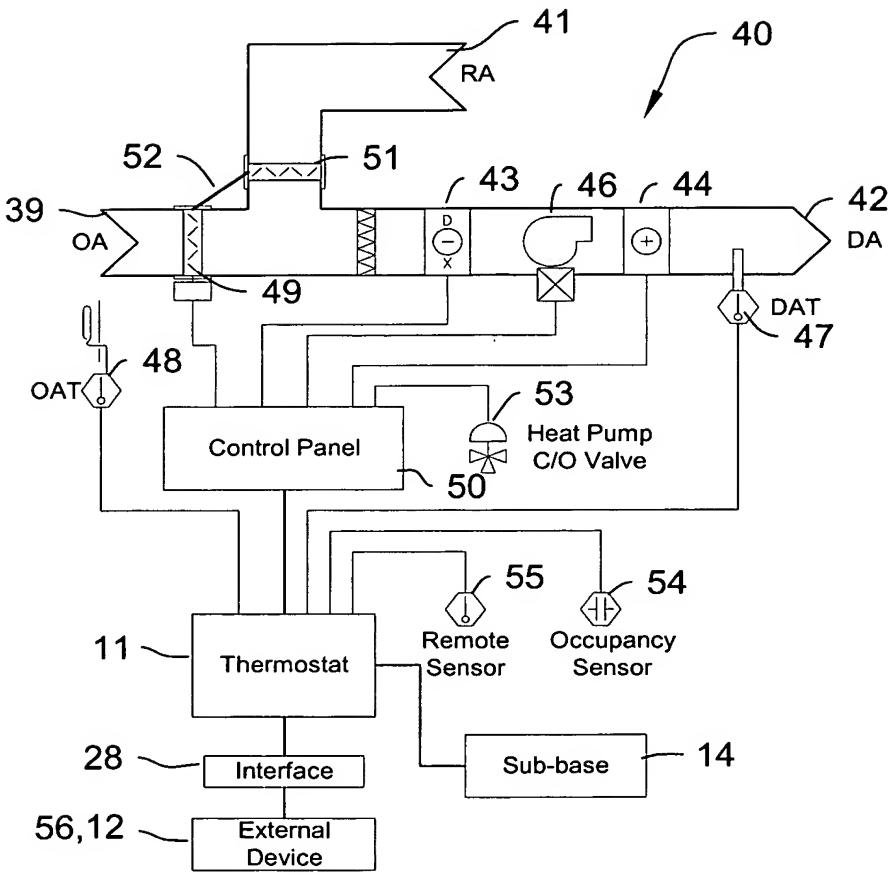
41
RA
40
52
51
43
46
44
42
39
OA
D
X
DA
49
DAT
47
48
OAT
53
Heat Pump
C/O Valve
Control Panel
50
55
54
11
Thermostat
Remote
Sensor
Occupancy
Sensor
28
Interface
Sub-base
14
56,12
External
Device

Figure 21

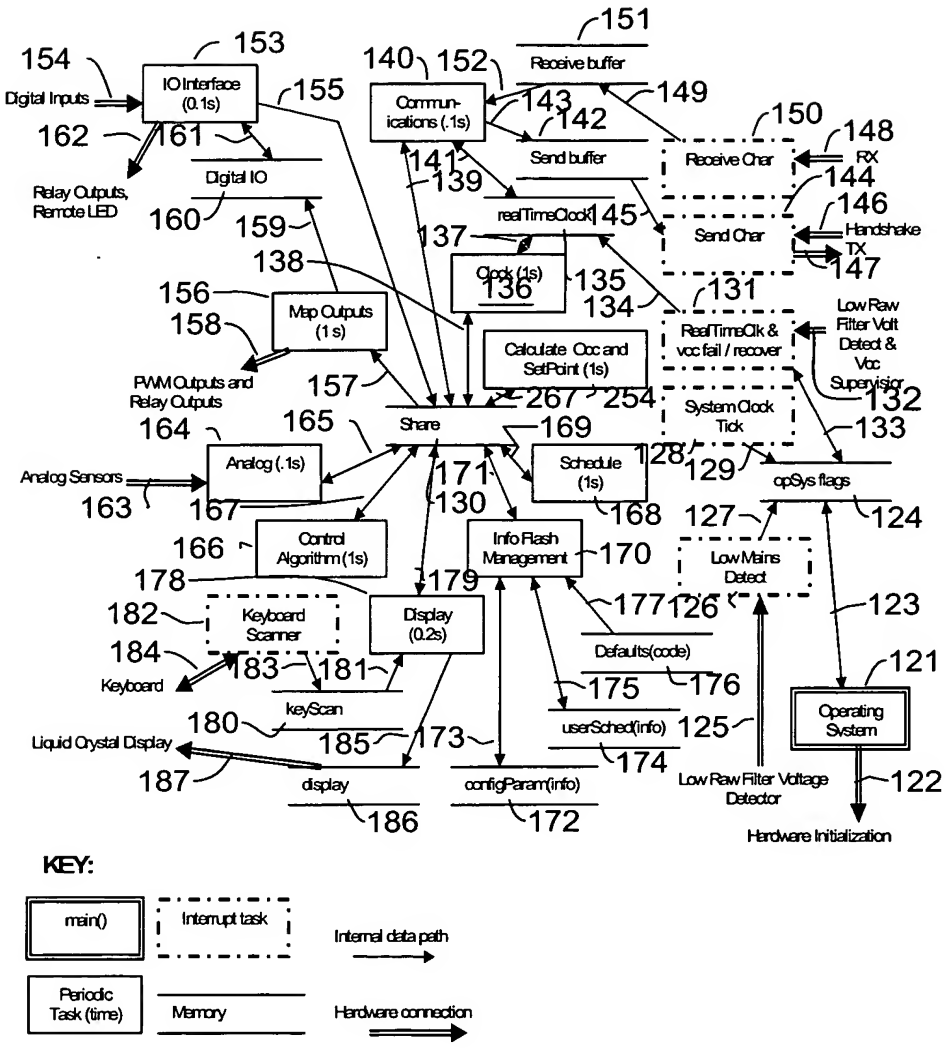
Digital Inputs
IO Interface (0.1s)
Digital IO
Relay Outputs, Remote LED
Map Outputs (1 s)
PWM Outputs and Relay Outputs
Analog Sensors
Analog (.1s)
Control Algorithm (1s)
Keyboard Scanner
Keyboard
keyScan
Liquid Crystal Display
display
Commun-ications (.1s)
Receive buffer
Send buffer
realTimeClock
Clock (1s)
Calculate Occ and SetPoint (1s)
Share
Schedule (1s)
Info Flash Management
Display (0.2s)
configParam(info)
userSched(info)
Defaults(code)
Receive Char
Send Char
RealTimeClk & vcc fail / recover
System Clock Tick
opSys flags
Low Mains Detect
Low Raw Filter Voltage Detector
Operating System
Hardware Initialization
RX
Handshake
TX
Low Raw Filter Volt Detect & Vcc Supervisor
KEY:
main()
Interrupt task
Internal data path
Periodic Task (time)
Memory
Hardware connection

Figure 22

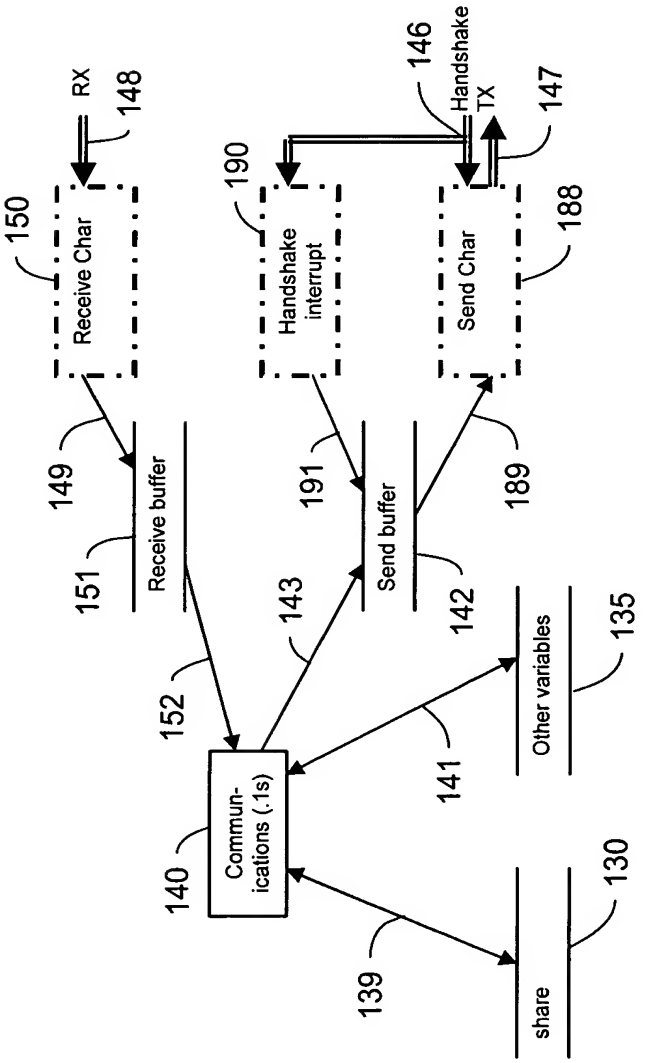
RX
148
146
Handshake
TX
147
150
Receive Char
190
Handshake
interrupt
188
Send Char
149
191
189
151
Receive buffer
Send buffer
143
142
152
141
Other variables
135
Commun-
ications (.1s)
140
139
share
130

Figure 23

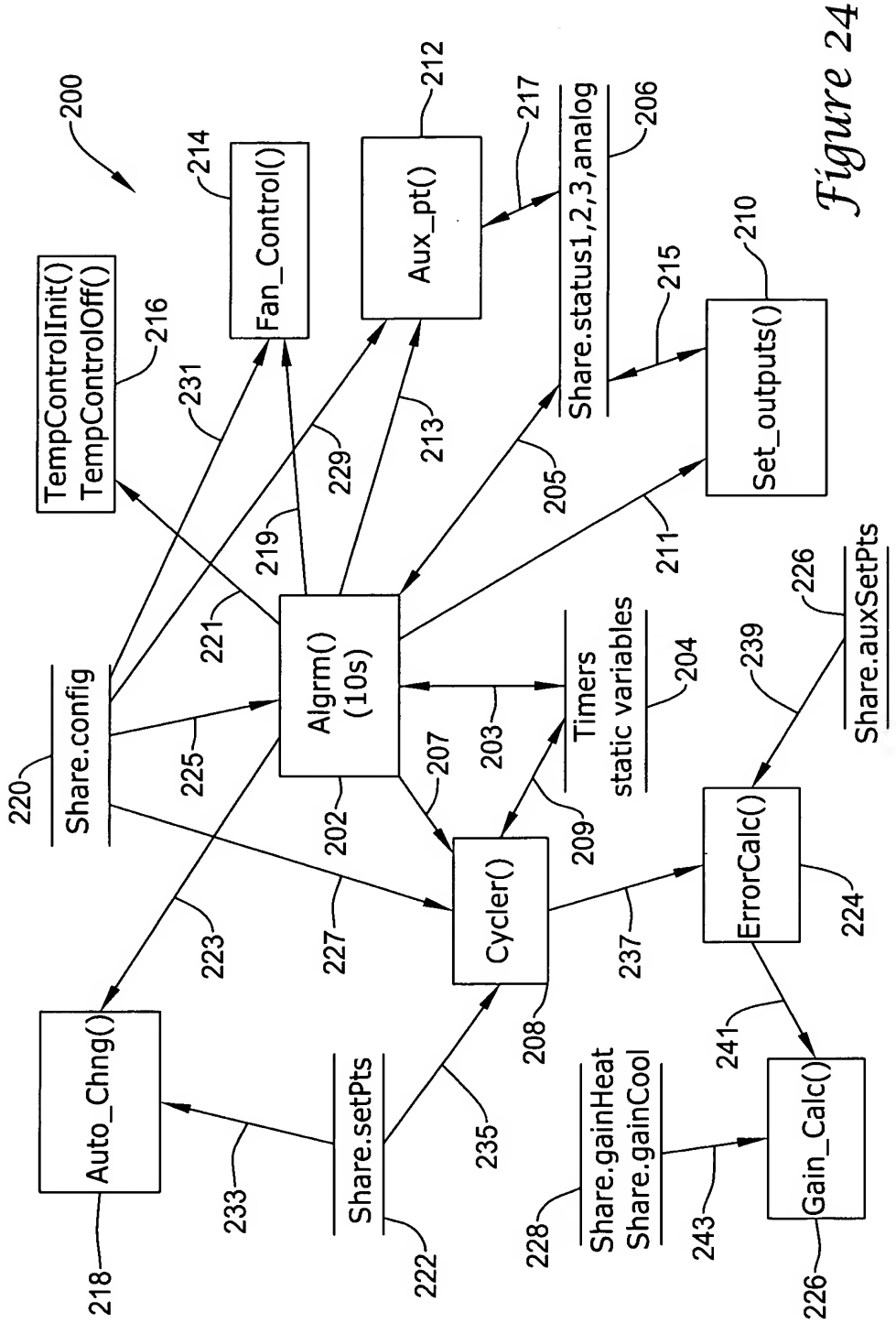
200
TempControlInit()
TempControlOff()
216
Fan_Control()
214
Aux_pt()
212
Share.status1,2,3,analog
217
206
Set_outputs()
210
215
231
229
213
205
219
211
221
Algrm()
(10s)
Timers
static variables
204
209
203
207
202
225
220
Share.config
Share.auxSetPts
226
239
ErrorCalc()
224
237
Cycler()
227
223
208
241
Auto_Chng()
218
233
Share.setPts
222
235
228
Share.gainHeat
Share.gainCool
243
Gain_Calc()
226

Figure 24

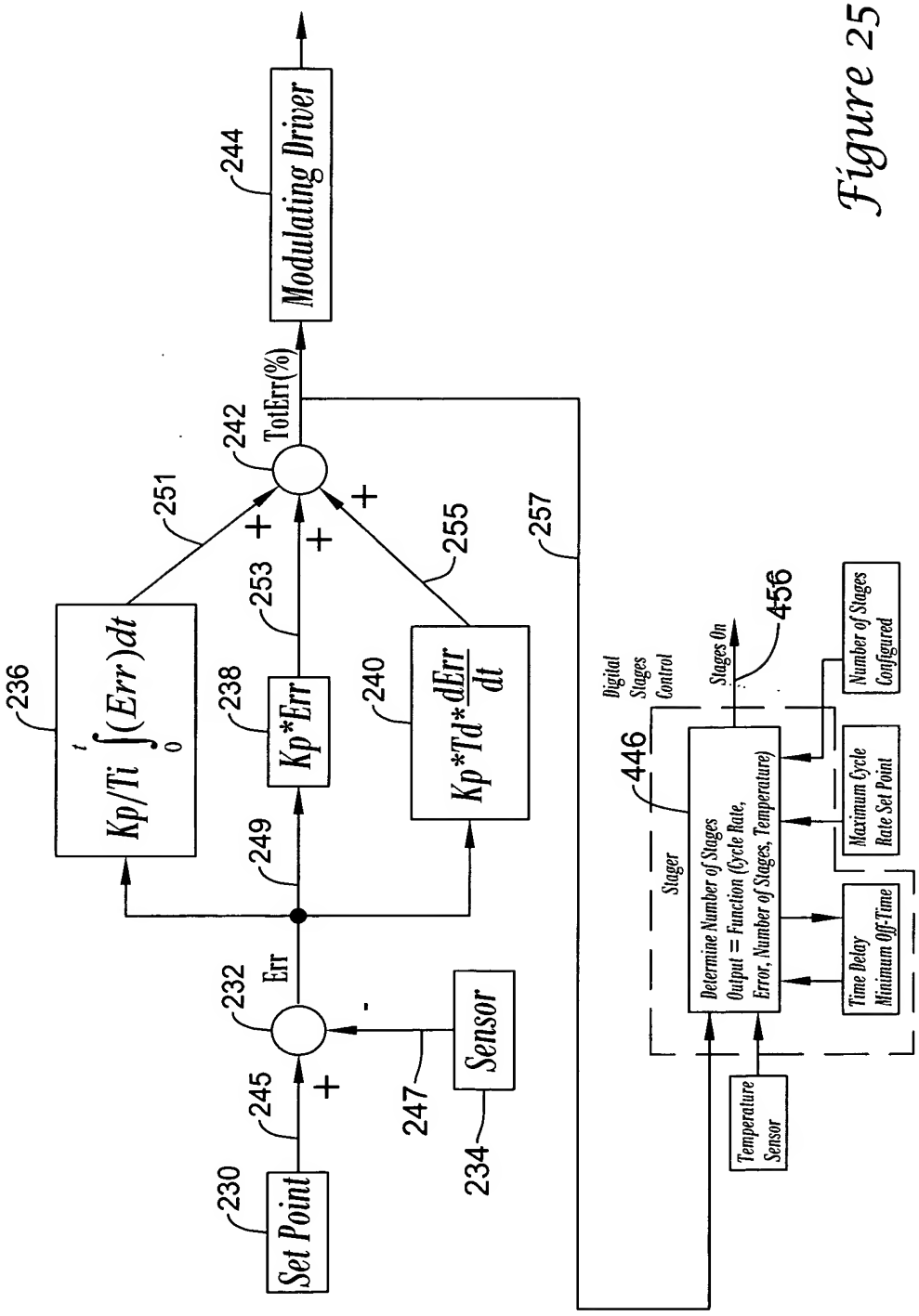
Modulating Driver
244
TotErr(%)
242
251
253
255
257
$Kp/Ti \int_0^t (Err)dt$
236
$Kp*Err$
238
$Kp*Td*\frac{dErr}{dt}$
240
249
Err
232
245
247
Sensor
234
Set Point
230
+
-
Digital Stages Control
Stages On
456
446
Stager
Determine Number of Stages Output = Function (Cycle Rate, Error, Number of Stages, Temperature)
Temperature Sensor
Time Delay Minimum Off-Time
Maximum Cycle Rate Set Point
Number of Stages Configured

Figure 25

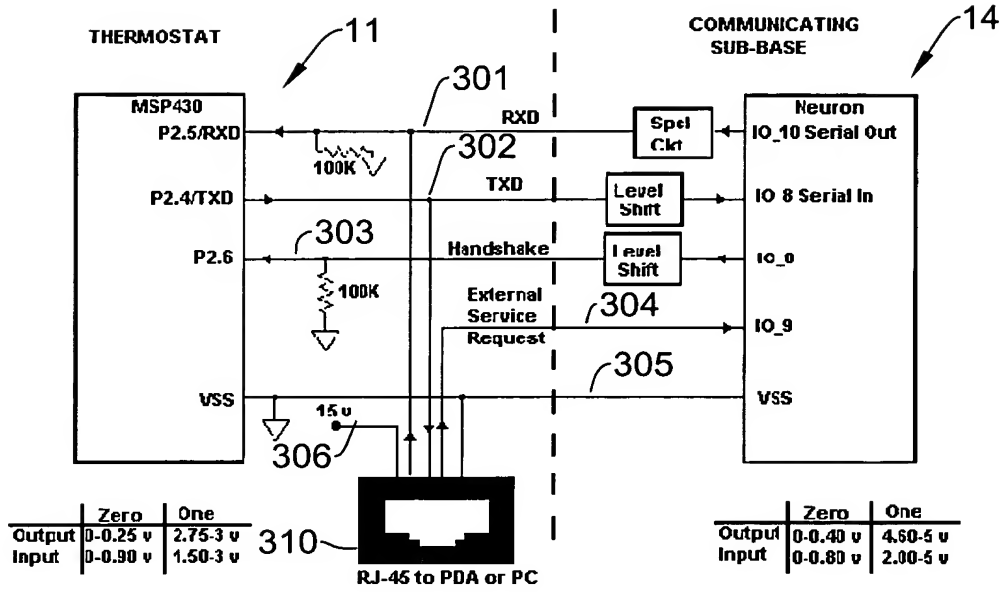

Figure 26

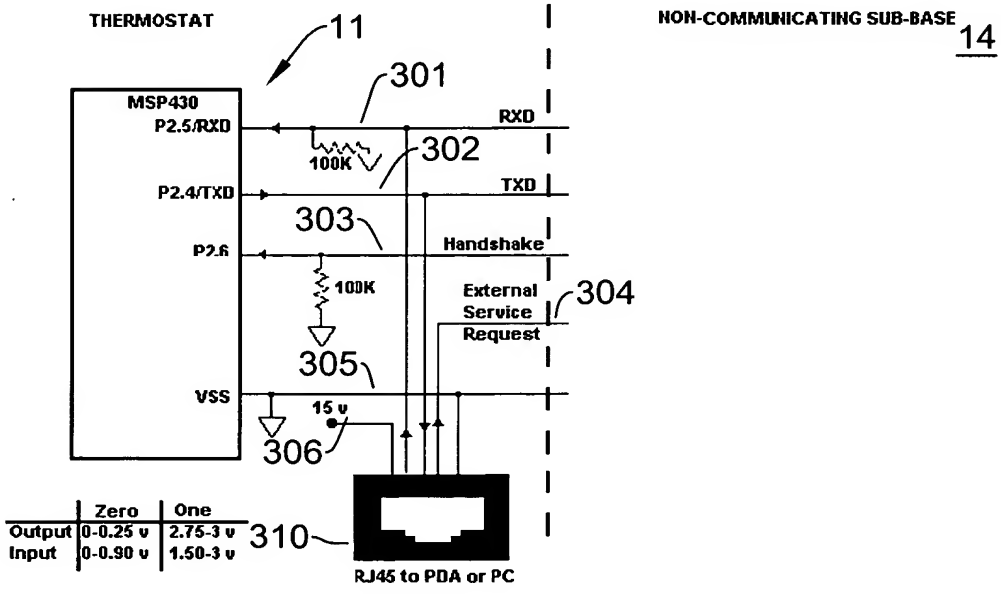

Figure 27

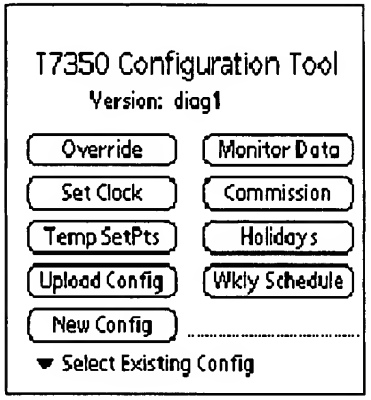

Figure 28A

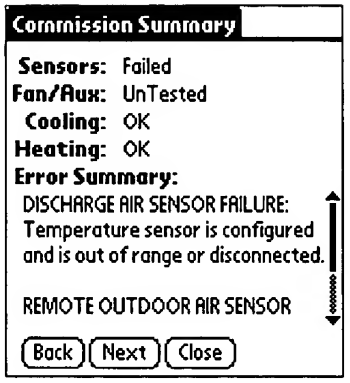

Figure 28C

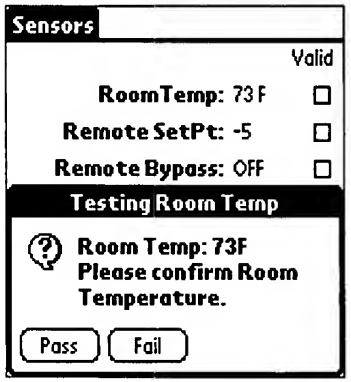

Figure 29B

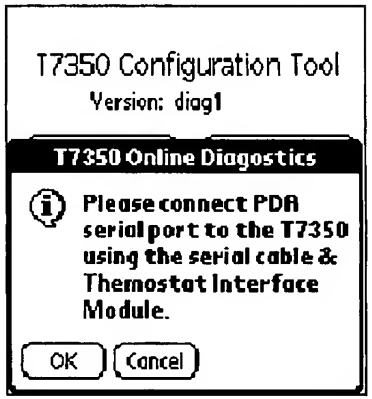

Figure 28B

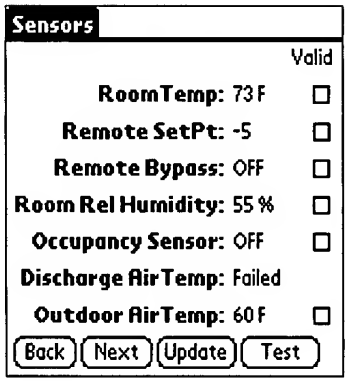

Figure 29A

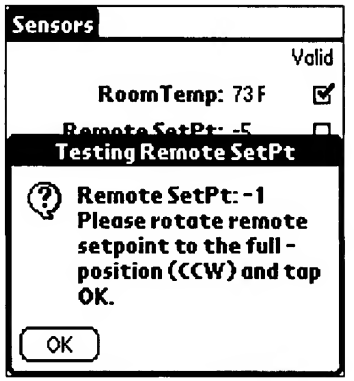

Figure 29C

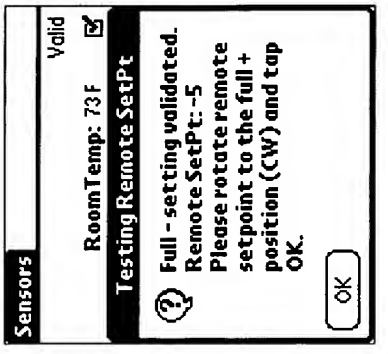

Figure 29D

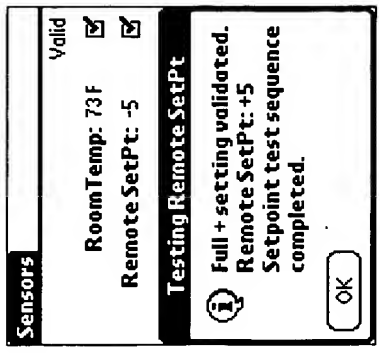

Figure 29E

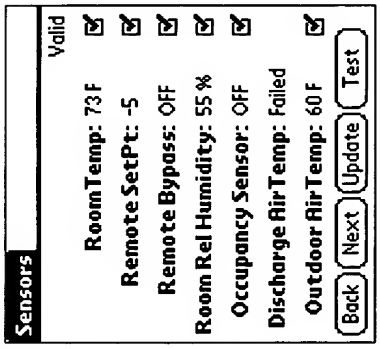

Figure 29F

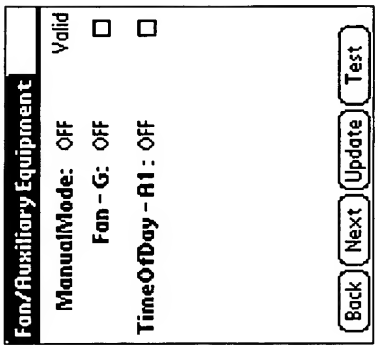

Figure 30

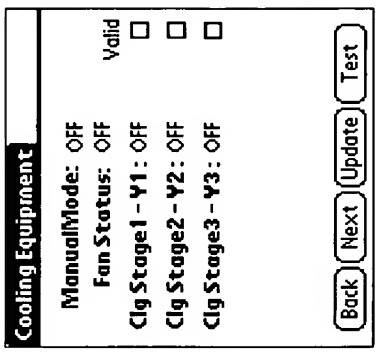

Figure 31A

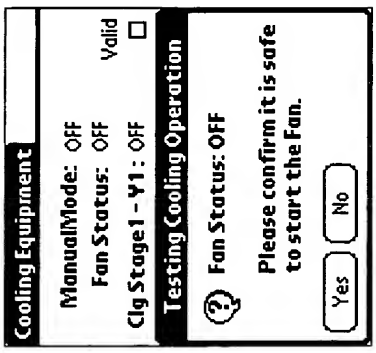

Figure 31B

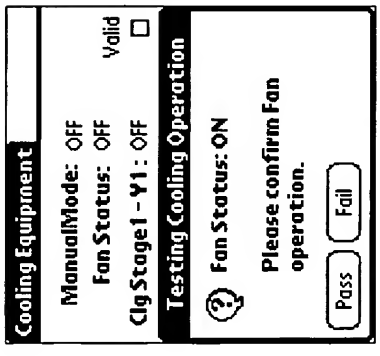

Figure 31C

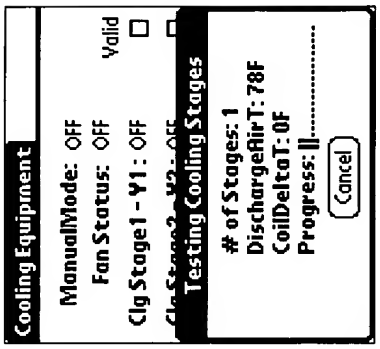

Figure 31E

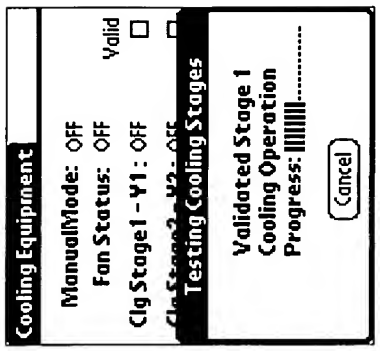

Figure 31G

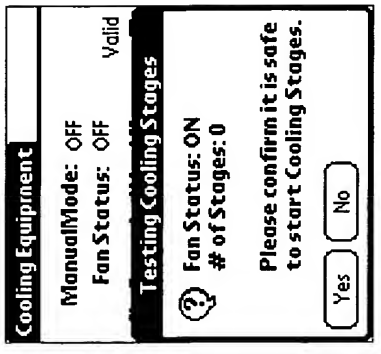

Figure 31H

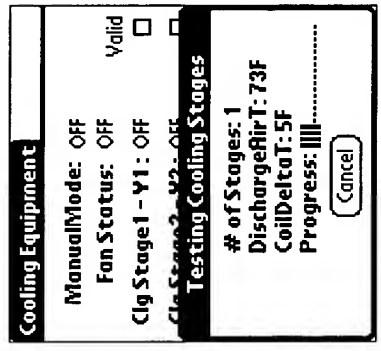

Figure 31F

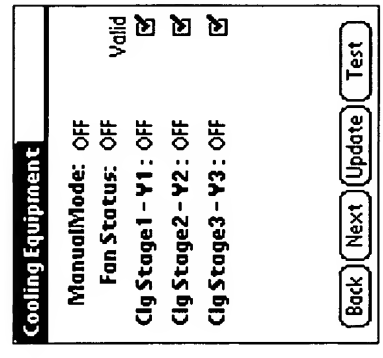

Figure 31D

Figure 32A

Figure 32B

Figure 32C

Figure 32D

Figure 32E

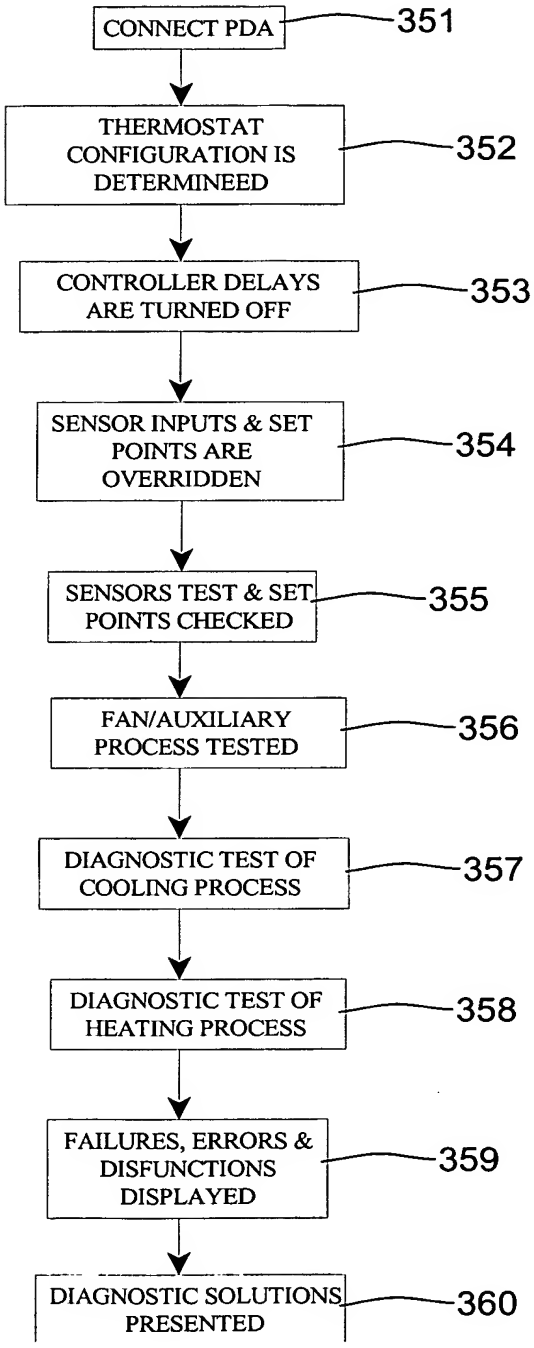
CONNECT PDA
351
THERMOSTAT CONFIGURATION IS DETERMINEED
352
CONTROLLER DELAYS ARE TURNED OFF
353
SENSOR INPUTS & SET POINTS ARE OVERRIDDEN
354
SENSORS TEST & SET POINTS CHECKED
355
FAN/AUXILIARY PROCESS TESTED
356
DIAGNOSTIC TEST OF COOLING PROCESS
357
DIAGNOSTIC TEST OF HEATING PROCESS
358
FAILURES, ERRORS & DISFUNCTIONS DISPLAYED
359
DIAGNOSTIC SOLUTIONS PRESENTED
360

Figure 33